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- PLATE X. Rosettes from a seedling tree near Sunny Side, Georgia. This tree showed symptoms of disease on only about one-half of its branches. On some of the branches the winter buds had germinated, especially toward the upper ends of the shoots. Photo, July 2, 1890.
- PLATE XI. Diseased peach tree from the budded orchard of T. C. Wells, Manhattan, Kansas. Much smaller than the average. Healthy in 1889, but now affected in all parts. There were no injuries by borers, root aphides, root knot, or *Scolytus*. The winter buds were germinating on some of the tufts. Photo, August 16, 1890.
- PLATE XII. Diseased branch from a seedling tree in the orchard of W. J. Griffing, Manhattan, Kansas. Whole tree affected in the same way. An extreme case of tufting. Photo, August 23, 1890.
- PLATE XIII. Diseased branch from a seedling tree in the orchard of W. J. Griffing, Manhattan, Kansas. The whole tree was affected. Photo, August 18, 1890.

TUBERCULOSIS OF THE OLIVE.

PLATES XIV, XV.

By NEWTON B. PIERCE.

During the summer of 1890, I enjoyed the opportunity of meeting, under the most pleasant circumstances, Dr. Luigi Savastano, professor of arboriculture of the Royal High School of Agriculture, at Portici; the latter a beautiful town situated at the base of Vesuvius, on the shores of the Bay of Naples. Dr. Savastano has recently done some excellent work on the tubercle disease of the olive, having conducted several series of experiments with cultures and inoculations which have resulted in clearly demonstrating the bacterial nature of this most interesting malady. These experiments have been carefully repeated by Dr. Fridiano Cavara, of the well-known agricultural school of Pavia, south of Milan. The result has been equally conclusive and interesting. It was my good fortune and pleasure to meet both Drs. Briosi and Cavara of this school, and to have the opportunity of seeing much of their valuable work. The writer was shown an olive tree into which bacilli of the olive tuberculosis had been introduced, and which was showing at the points of infection well-developed tubercles. At its side stood another olive of like size and similarly conditioned, which had been treated in all ways as its companion with the exception that the wounds made by the knife had never received the germs. No signs of a tubercle were to be seen upon this tree. The organisms used in these experiments were from artificial cultures.

During the author's labors in the Mediterranean region, tuberculosis of the olive was encountered at several places and under various conditions. On this account the liberty is taken to append a note or two to a translation of the published account of the concluding experiments of Dr. Savastano.* There is also given a reproduction of figures pub-

* *Il Bacillo della Tubercolosi dell' Olivo, Nota Suppletiva del dott. L. Savastano.* Roma, 1889.

lished by Drs. Cavara and Briosi, showing the section of a tumor with the location of the bacilli in the tissues, as well as the germs themselves as seen in the stained preparations on the slide. I was shown while at Pavia the preparations from which the sketches were drawn, and will say they are fairly represented in the figures given. To supplement this there have been added figures from my own material and photographs of affected olive branches, showing the location and various stages of the tumors *in situ*.

Dr. Savastano's account of the disease is as follows:

In my study of the tuberculosis of the olive (commonly *scab of the olive*)* I established the presence of a pathogenic microorganism in the tumors, cultivated it, inoculated with it, and obtained by means of it the formation of tumors. I explained that owing to circumstances over which I had no control I was unable to complete the study of this microorganism with the thoroughness which bacteriology requires. Having obtained the means for undertaking the researches in the bacteriological laboratory of the Zoölogical Station at Naples,† I have resumed the study which I was reluctantly obliged to leave incomplete.

The characteristics of the pathogenic microorganism of the tuberculosis of the olive are the following: The cultures are made in a way to avoid error only when incipient tumors are used. If they are made from old tumors it is necessary to take the inner part of the cambium zone. Taking the external part, only the microorganisms of the air are found.

This microorganism is a *Bacillus* of medium size; length three to four times its width; it is isolated, but is sometimes joined into chains; the extremities are slightly rounded off. In drops of bouillon it has a distinct movement. The colony has a variable form, from round to oval, with a well-defined margin. In the beginning it is uniformly pointed; later it forms one or two peripheral circles. It is whitish by reflected light, cedar-color by transmitted light. The bacillus lives well in ordinary culture media (bouillon, potato, gelatine, agar). I have attempted to make another medium for culture with material taken from the olive. It did not prove very suitable, and the preceding media are preferred. Gelatine does not liquefy in our climate from January to April; from May to June it liquefies slowly. The culture has a relatively long life; cultures made in March were still living in June. In short, degeneration begins in about 3 months. The bacillus stains very well with simple aniline colors. I have not been able to establish a distinct spore formation. The method of double staining does not succeed very well, because the cell wall takes up the aniline colors more easily and gives them up with greater difficulty than the microorganisms.

On the potato it lives very well and develops rapidly; the colonies are at first like so many small round dots, translucent straw-color, which, as they develop, form on the surface of the potato a uniform stratum, translucent, and of a deeper color. The bacillus acquires greater dimensions.

On the gelatine plates it lives very well, with characters and forms as above indicated. In tubes of gelatine *a becco* the culture presents the appearance of a uniform stratum, whitish, the margin finely bilobed, reminding one of the margin of a leaf, the whole culture taking the form of a spatulate leaf. It is slightly dichroic.

* *Tubercolosi, iperplasie e tumori dell' olivo. I. II. Memoria.* Annuario R. Scuola Sup. d'Agricoltura in Portici, Vol. v, fasc. 4, 1887.

† The equipment for bacteriological work in the Naples Station has been but recently added, we believe. The station now has the facilities for doing good work of this class. Mr. H. Linden, in charge of the station, who has our thanks for courtesies extended during our stay at Naples, fully convinced us, after a careful inspection of the laboratories and general accommodations of the institution, of the desirability of more American students reaping the benefit of the advantages there offered.—N. B. P.

In tubes of agar *a becco* the culture is indential with the preceding, the margin is less bilobed.

The culture by needle in gelatine presents a uniform, transparent, finely pointed appearance. On the surface of the meniscus the form is irregularly rounded with a finely lobed margin as in the preceding.

In the different materials taken from the olives of Puglia, Calabria, the Vesuvian region, and the Sorrentine peninsula, I have demonstrated in each case the same microorganism in the cultures.

In tumors which had been gathered about a year the *Bacillus* had been destroyed.

In the cortical tubercles and in their miliary form I have demonstrated the same *Bacillus*. I have performed three series of inoculation experiments. I have practiced the same method of inoculation which I had before adopted.

Series I. Inoculation of pure cultures in olive plants.—The plants used were all grown from seed, some were raised by myself, others were given me by Signor R. Pecori, of Florence, from his establishment. The plants were taken from seed and not from cuttings, to avoid heredity from the mother plant which might be infected.

The inoculations were made April 27 of the current year. By the 1st of June the tumors were already evident, and by the 1st of July were much developed. The controls have not given signs of tumors. These results are the confirmation of those obtained roughly by me and with impure cultures in 1887. I am able to conclude that *the disease of the tuberculosis of the olive (commonly scab) may be produced by a specific pathogenic Bacillus which I name Bacillus olea-tuberculosis*, understanding the tubercle in the sense of botanical pathology.

Series II. Inoculations of the Bacillus in other plants.—The conditions of inoculation are identical with the preceding and on the same day in the following plants: peach, plum, apricot, grape, fig, pear, apple, bitter orange, lemon, rose, *Abies excelsa*, *A. pectinata*, *Cedrus Libani*. Till now (July 30) I do not see the least sign of a tubercle; the wounds are perfectly closed and healed. I am able to conclude from this that *these bacilli are not able to produce the same pathological effects in the plants indicated*.

Series III. Inoculations of other microorganisms in olive plants.—With the identical conditions preceding I inoculated into olive plants the following microorganisms which I am studying in the said Zoölogical Station: (1) A bacillus obtained in small tubercular swellings of the plum; (2) a second bacillus obtained as the preceding; (3) a bacillus found in the gums of citrous plants; (4) one of the bacilli of the pus of the citrous plants; (5) a bacillus of the cancer of the vine. Not one of the many inoculations has produced a tumor. Could this be done the tuberculosis might be produced by any microorganism whatever. *This third series of experiments indicates much more certainly the pathogenic power of the Bacillus of the tuberculosis of the olive.*

General observations.—The tubercle of the olive is an excrescence upon the limb of the tree which might pardonably be at first mistaken for an insect gall. These excrescences or tumors are quite variable in size, probably most of them are mature before reaching an inch in diameter, but some become large coarse knots. Many branches cease to grow, in whole or in part, beyond the tubercle, after the latter has become partially developed. Some branches become stunted while others die entirely toward the end. Hence the growth of the tubercle is largely limited by the vigor and life of the limb bearing it.

Dr. Savastano says* that the tubercles occur upon branches from 1 to 15 years of age. In forming, the tubercle commonly takes its origin quite near the cambium zone, though more frequently the center of bacteria begins to form in the liber portions of the fibro vascular bundles. To the unaided eye the forming center appears like a very small

* *Comptes Rendus*. Paris. T. ciii, p. 1144.

transparent spot, which, under magnification of 1,000 diameters shows the colony of bacteria already formed. There is now manifest about the colony a hypertrophy of the elements which may become more or less profoundly altered. As the colony enlarges the hypertrophy increases. The tubercle grows until in time it cracks through the exterior bark. When the tubercle is formed its growth is not usually arrested, but it continues to increase more or less in size each year, often attaining a diameter of 0.01 to 0.02 meter (two to four fifths of an inch). The tubercle is formed in the spring; during the heat of the summer the hypertrophy is arrested, but the colony of bacteria increases considerably. Then, during the autumn renewal of growth the hypertrophy begins again.

The irritation or stimulation caused by the presence of the bacillus, so far as our observations have extended, produces only a localized growth of tissue. There is scarcely more evidence of a general or constitutional disorder of the sap of the tree affected than is produced in the oak under the action of the *Cynipidæ*. The stimulation of the affected branch scarcely extends beyond the node or internode where the swelling occurs. The impoverishing action of this growth, however, is often plainly observed on the entire twig beyond the tubercle. The limb sometimes shows a marked reduction in diameter, though perhaps green and healthy in other respects. In a majority of cases the enlargement only involves one side of the branch. It is not uncommon to find two centers of inoculation producing coalescing tubercles; but the distinction of origin is rarely lost. So far as I am aware progressive death of the limb below the point of infection, as is the case with pear-blight, never occurs. There is no analogous and general pathogenic degeneration of the tissues as found in limbs affected by that disease.

From some of my first observations, where I found the tubercle developing at the node of the limb, I thought it likely that inoculation had been effected by means of the axillary buds. Later, however, many tubercles were noticed, located upon internodes, and having no connection with the leaf axil. This has left the method of entrance of the *Bacillus* obscured, unless, perchance, it be through the growing point, and continued growth has left it within the internode or at the node. This explanation seems more probable than that the organism has directly penetrated the bark of the branch. It is also rather indorsed than otherwise by the fact that whenever mechanical injury has occurred to the bark, laying bare the cambium tissue, the tumors are often unusually numerous. They are most common where a bud or leaf or branch has been broken off, or where some injury or splitting of the branch has occurred. In one case observed, where a branch had been split for a few inches, three distinct centers of inoculation were seen at the edge of the ruptured bark within the distance of 2 inches. Undoubtedly, however, inoculation may occur through slight cracking or other injury of the bark.

The local and general distribution of tuberculosis of the olive is peculiar and interesting. There is no such sweeping and complete infection accomplished by this disease as is the case in the spread of many germ diseases. I was told that near Genoa the disease is very common and quite destructive. At Rome I visited an olive grove near Colonna, some 16 miles from the city and north of the Alban Hills. In company with Professor Cuboni I made careful search for this disease, and only obtained a single tumor from a considerable number of trees examined. Another case somewhat similar occurred at Portici. The agricultural school building there was formerly a royal residence, and retains back of it an extensive park which was fitted up in connection with the residence or palace. Here is an extensive olive grove. Dr. Savastano, his assistant, and myself searched through this grove for some time for tubercles, only finding, at last, a few on the upper limbs of a single tree. At Cancelli, some 12 to 15 miles north of Vesuvius, is a large olive grove covering the hills at that place. I here spent several hours in a fruitless search for this disease; at Palma, about an equal distance southeast of Cancelli, the trees were quite badly infected. Upon a single small branch (the one shown on Plate XIV) I counted not less than twenty-nine swellings. All about the hills north of Messina, Sicily, especially in the neighborhood of Faro, the olives are badly infected, and in one or two cases nearly the entire top of the infected tree was ruined. In the province of Syracuse, where olives are largely grown, and where they are very old and thrifty,* no signs of this disease were seen. At Palermo, northwest Sicily, it was again encountered, and noted as being the worst phase of the disease seen up to that time. In Algeria I did not encounter the trouble, but have little doubt of its existence there, as well as in all of the Mediterranean olive-growing countries. It exists in France. My observations show me that the disease is very irregular in its distribution. One olive grove may be free from it, or nearly so, while another not far distant may be badly infected. One tree in a grove may be, apparently, the only one infected. Again, the disease may be localized upon one portion of a single tree. Probably nothing short of a clear understanding of the means of distribution and infection will explain these facts.

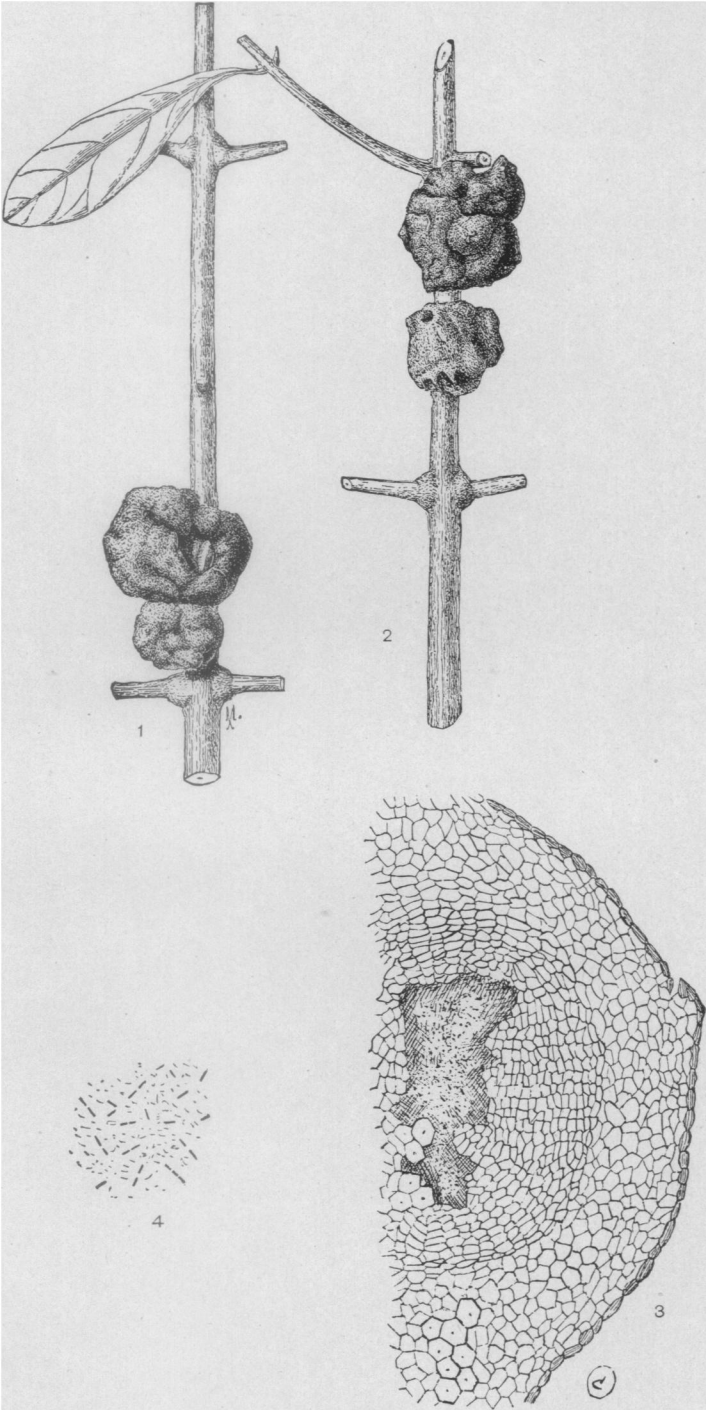
Careful attention to the excision of all affected branches is apparently all that is required to keep this affection from spreading and doing serious damage.

As the olive industry is becoming one of importance on the Pacific coast, it is well that those interested should have the facts relative to the various enemies of that industry placed before them. In this way they may become familiar with those diseases not yet affecting their groves, and may take steps which shall prove an ounce of prevention worth more than a pound of cure.

* Near Florida, some 14 miles west of Syracuse, I found one magnificent old olive tree in perfect health, which measured 13 feet in diameter at the ground and 10 feet in diameter at 3 feet above the ground.



PIERCE ON OLIVE TUBERCULOSIS.



PIERCE ON OLIVE TUBERCULOSIS.

EXPLANATION OF PLATES.

OLIVE TUBERCULOSIS.

PLATE XIV. Olive branch 18 inches long, bearing 29 tubercles, only part of which are seen in the plate, and none are fully matured. Several of the tubercles have but recently broken through the bark of the branch. This branch was cut July 29, 1890, from a badly infected olive tree growing in an old grove two miles south of Palma, in the province of Naples, Italy. Photograph of fresh material.

PLATE XV. FIG. 1. Well-matured olive tubercles of natural size, showing the usual ruptured condition of the top. The rupturing is preceded by a slight pitting at the surface, as shown in the lower tumor. Material from near Genoa, Italy.

2. Olive tumors from the same source as those of Fig. 1. The lower tumor shows an opening through which some insect has escaped, which inhabits the old tumor, and which may assist in spreading the disease.
3. Section through a tumor. Shows the hypertrophy of the tissue and the degeneration at the central part of the tumor where the bacilli are situated. After Briosi and Cavara.
4. *Bacillus oleæ* (Arcangeli), Trevisan. From figures of stained slide preparations by Briosi and Cavara. I have seen the original preparations given in Figs. 3 and 4.

RECENT INVESTIGATIONS OF SMUT FUNGI AND SMUT DISEASES.

AN ADDRESS DELIVERED BEFORE THE SOCIETY OF AGRICULTURISTS OF BERLIN,
FEBRUARY 17, 1888.

By Dr. OSKAR BREFELD,

Full Professor of Botany in Münster in W.

Translated from *Nachrichten aus dem Klub der Landwirthe zu Berlin*, Nos. 220-222, by
Erwin F. Smith.

(Continued from p. 71.)

For the solution of the first question some important data have been pointed out already in speaking of the mode of infection, to wit, the application of the germs and their penetration into the host. From the results of the first five series of experiments it is evident that the period of receptivity in the seedlings is very transitory. The slower this stage of growth the more probable it is that the germ which has penetrated at the right spot will actually reach the growing point in the given time; and this must be reached if the nascent blossoms and fruits (the subsequent location of the smut beds) are to become smutty. On the contrary, the more rapid this stage of growth the less must be the probability that the germ can reach the growing point in the short time before the seedling begins to elongate. And from this point of view the most extreme case would be when a very greatly hastened development of all seedlings altogether prevented the passage of the penetrated germ into the growing point; in this case, in spite of all penetrated germs, the appearance of the smut diseases would be impossible.